Check List the journal of biodiversity data

LISTS OF SPECIES

Check List 11(3): 1627, April 2015 doi: http://dx.doi.org/10.15560/11.3.1627
ISSN 1809-127X © 2015 Check List and Authors

Exotic and invasive fishes in Mexico

Héctor Espinosa-Pérez* and **Montserrat Ramírez**

Universidad Nacional Autónoma de México, Instituto de Biología, Departamento de Zoología: Colección Nacional de Peces, Ciudad Universitaria, 3er Circuito Exterior s/n 04510 Mexico City, D.F., México

* Corresponding author. E-mail: hector@unam.mx

Abstract: This paper presents a list of the exotic fish species introduced in Mexican aquatic systems. This list is the result of the systematized information contained in several databases of ichthyological collections around the world and different publications. A total of 104 species were found, distributed in 19 families and 51 genera. The most species-rich were Cyprinidae with 22 species, Poeciliidae (19 species), Cichlidae (15 species) and Centrarchidae (13 species). A map and an electronic database were created based on the knowledge of the species, showing the known introductions of exotic fishes in the country. The information was obtained from a database stored in the Colección Nacional de Peces IBUNAM, which can be accessed online. This study has a high importance for the knowledge of the exotic fish fauna of Mexico and its current status.

Key words: exotic fishes, Mexico, databases, electronic map, introductions

INTRODUCTION

Fish are the most diverse group of vertebrates, and freshwater fish are especially considered as one of the most seriously threatened animal groups, because of the introduction of exotic species (non-native), it means, species that do not belong naturally to an aquatic system (CONABIO 2008). These species cause damage to ecosystems by the deterioration of the water body, and strong effects on native communities in which they are inserted (Contreras-Balderas 1999). The introduction pathways of fish and other organisms may be deliberately, for purposes of aquaculture, sport fishing, biological control or protection of species and forage, or accidentally including leakage of individuals from farms, discharge ballast water, hydrological systems channeling and the release of species used as bait in a different system from where they were collected (Gozlan et al. 2010).

Frequently, introduced or exotic species are mistaken as invasive species, the latter considered as those whose abundance and distribution are significantly greater than when the species was first introduced. Although the term is widely used, there is no clear definition to designate a species as *invasive*, as there is some subjectivity in its use (Wittenberg et al. 2001). For practical purposes, this paper defines invasive fish as non-native species that, once introduced to a water system, its reproductive success allows it to establish and significantly increase its distribution. This contribution aims to update the list of invasive species of Contreras-Balderas (2008), and includes a list of invasive species and their effects on introduction environments. An interactive database, stored electronically in the Colección Nacional de Peces of Instituto de Biología UNAM, which can be consulted online.

MATERIALS AND METHODS

Records of exotic fish caught in seas, rivers, lakes, ponds, reservoirs and streams were obtained from the following database: Colección Nacional de Peces del Instituto de Biología, Universidad Nacional Autónoma de Mexico (CNPE-IBUNAM), Centro de Investigaciones Biológicas del Noroeste (CIBNOR), Colección Ictiológica de la Universidad Autónoma de Baja California (CI-UABC), Departamento de Investigaciones Científicas de la Universidad de Sonora (DICTUS-USON), Academy of Natural Sciences, Philadelphia, (ANSP), Canadian Museum of Nature, Ottawa (CMNFI), Cornell University, Vertebrate Collections, Ithaca (CUMV), University of Florida, Florida Museum of Natural History, Florida (UF), Field Museum of Natural History, Chicago (FMNH), Biodiversity Institute, University of Kansas, Lawrence (KU), Michigan State University Museum (MSUM), Texas A&M University, Texas Cooperative Wildlife Collection, (TCWC), Tulane University, School of Science and Engineering, Department of Ecology and Evolutionary Biology, New Orleans, (TU), Universidad Autónoma de Nuevo León, Escuela Nacional de Ciencias Biológicas (UANL), University of Michigan, Museum of Zoology, Ann Arbor, Michigan (UMMZ)

and Smithsonian Institution, Washington, DC (USNM). A great number of the records (3478) were taken from the database CONABIO recorded by Contreras-Balderas (2008) and from the records obtained online from public and international databases such as Global Biodiversity Information Facility (GBIF) and the FishNet data portal (FishNet2.net), which gather numerous references of various species throughout the world. Literature and faunal lists were also reviewed, such as Ruiz-Campos et al. (2012), which include records of exotic species in the peninsula of Baja California, the faunal list Contreras-B and Escalante-C (1984), Contreras-Balderas (1999) or Mendoza and Koleff (2014).

A map and an interactive database were done with all data obtained from the databases. Entries were standardized, overlapping records were eliminated and spelling errors were corrected. Records with accurate geographical coordinates were used; coordinate acquisition of each locality was achieved *a posteriori* by mapping and matching (less than 10 m in diameter) the collection site to a water system. For this purpose the online service GEOLocate and Fishnet2 were used, as well as GIS Google Earth 6.0. Fish nomenclatures were verified according to recent taxonomic revisions, following the arrangement of Page et al. (2013) and the Catalog of Fishes (Eschmeyer and Fong 2014). The list of introduced and exotic species in Mexico is shown in Table 1, with their native distribution the area of occurrence in Mexico including known distributions and samples of collection, the causes of the introduction, the current status of invasion and the catalog number of the specimens deposited in fish collections. The species are listed in four categories: exotic, introduced, invasive and required to verify. "Exotic" includes foreign species *sensu stricto*, those that comes from other countries. "Introduced" refers to species that have been introduced in a water system by anthropogenic purposes, such as aquaculture, and those species that were translocated due to sport fishing, bait, or reintroduced for conservation purposes. "Invasive" refers, as in the introduction, to those species that have established and are widely distributed in different water bodies of Mexico. "Requires verification" concerns to those species not deposited in a scientific collection, as *M. anguillicaudatus* (Cantor, 1842). This category also includes those species whose distribution overlaps their native distribution.

RESULTS

Nineteen families, 59 genera and 104 species of exotic fish have been introduced in the Mexican water systems. An analysis of the families of all species reported is presented below. The database and electronic map presented in this work can be consulted online using the link http://unibio.unam.mx/peces_exoticos-war/, and show the records of introduced fish species reported by Contreras-B and Escalante-C (1984) and Contreras-Balderas (1999). The localities in which the introduced species were observed or collected, as well as the number of records by locality of the selected species are also shown.

Lepisosteidae: Although four species of this family are native to Mexico and North America, from Canada to Nicaragua, at least *Lepisosteus osseus* (Linnaeus, 1758) is known to be imported from the United States, where it is stocked for conservation purposes. In Mexico, stocking of this specie is done for sport-fishing and riverine fishing in Tamaulipas dams (García de León et al. 2005).

Clupeidae: Data of introduction or translocation of *Dorosoma cepedianum* (Lesueur, 1818) and *D. petenense* (Günter, 1867) in rivers, lakes and reservoirs in the north of Mexico are available according to Contreras-B and Escalante-C (1984). These species are native to the Atlantic coast, northeast and southeast of Mexico, but have been introduced as forage species for food to other species such as Largemouth Bass (*Micropterus salmoides* (Lacepède, 1802)). Currently there are more records of these two species in the northern and southern regions of the country, but the effects in native populations are not known.

Chanidae: The species *Chanos chanos* (Forsskål, 1775) was introduced in America by the end of the last century in the San Francisco estuary, United States of America, where according to Castro-Aguirre et al. (1999) it does not occur. Its current distribution extends from the southwestern coast of Baja California Sur and the Gulf of California to Panama and Galapagos Islands, and in lagoons of Sinaloa, Nayarit, Jalisco, Guerrero and Chiapas, in Mexico. This species is native to the Red Sea and the Indian Ocean.

Cyprinidae: Twenty-two species of this family have been recorded as non-native, introduced on Mexican water bodies, many of them are translocations or unverified records of Mexican species in other systems. Among them are: *Algansea lacustris* Steindachner, 1895, introduced in many aquatic systems in central Mexico. It is unknown whether the species is established or not, but there is suspicion that it has hybridized with other species of the genus (Escalante and Contreras 1985). *Cyprinella lutrensis* (Baird & Girard, 1853) was documented by Contreras-Balderas et al. (2008) as introduced, and mentioned it in multiple localities in the north. Ruiz-Campos et al. (2012) suggested the species to be probably responsible of the decline of the Desert Pupfish *Cyprinodon macularius* Baird & Girard, 1853. Other species such as *Gila bicolor* (Girard, 1856), *G. modesta* (Garman, 1881) and *G. orcutti* (Eigenmann & Eigenmann, 1890) natives from the United States were documented by Contreras-B and Escalante-C

(1984) in Baja California, but these species were not found by Ruiz-Campos et al. (2012). *Campostoma anomalum* (Rafinesque, 1820), *Macrhybopsis aestivalis* (Girard, 1856), *Notropis chihuahua* Woolman, 1892, *N. amabilis* (Girard, 1856), *Pimephales promelas* Rafinesque, 1820 and *P. vigilax* (Baird & Girard, 1853) were also documented as introduced species, possibly used as bait by fishermen, but no recent records was found (Contreras-Balderas, 1999). *Notemigonus crysoleucas* (Mitchill, 1814) inhabits waters in the Rio Grande basin, mainly in Tamaulipas. The only two records from Lee et al. (1980) on the coast between California and Arizona are not enough to conclude that the species is established. The remaining 11 species of Cyprinidae are exotic to the country, naturally from India, Sri Lanka and China. Two of these species: *Pethia conchonius* (Hamilton, 1822) and *Puntius titteya* (Deraniyagala, 1929) were introduced for ornamental purposes and their status is unknown, although Contreras-B and Escalante-C (1984) mentioned them as probably established in Nuevo Leon (northern Mexico), but no recent record has confirmed this information. However, a new record of *P. conchonius* was recently found in a dam in Guerrero (southern Mexico) and the specimen was deposited with the catalog number in CNPE-IBUNAM 20010. The other exotic cyprinids were introduced mainly by accidental releases of aquaculture (Ibáñez et al. 2011) and are invading several water bodies in the country. Species such as *Abramis brama* (Linnaeus, 1758) and *Megalobrama amblycephala* Yih, 1955 were introduced in the State of Mexico and their current distribution is unknown. *Cyprinus carpio* and its subspecies or varieties: *Carassius auratus* (Linnaeus, 1758), *Ctenopharyngodon idella* (Valenciennes, 1844), *Hypophthalmichthys molitrix* (Valenciennes, 1844) are considered invasive species with a wide distribution in several water bodies, two new specimens of *Hypophthalmichthys nobilis* (Richardson, 1845) was recently captured in 2002 in the Laguna de San Antonio Rayon, Tamaulipas, whereas *Mylopharyngodon piceus* (Richardson, 1846), was reported by Contreras-Balderas (1999) as a farmed species without currently new records.

Catostomidae: *Carpiodes carpio* (Rafinesque, 1820) was reported by Hendrickson et al. (1980) in Presa Novillo where it was extremely common in shallow areas in the early seventies. Its distribution is from Mississippi basin from Pennsylvania to Montana, south to the Gulf of Mexico drainages from the Mississippi River to Mexico (Contreras-B and Escalante-C 1984), therefore could be considered as translocated species, nevertheless its status is currently unknown.

Cobitidae: *Misgurnus anguillicaudatus* (Cantor, 1842) from Asia is considered of high risk to the native Mexico species, for its easy adaptation to almost any aquatic environment and its high rate of depredation. In Mexico it was introduced in the sixties into the channels of Chapingo, State of Mexico, due to its potential for aquaculture. It is apparently not established due to water pollution and loss of habitat in the region (Contreras-B and Escalante-C 1984).

Loricariidae: *Pterygoplichthys disjunctivus* (Weber, 1991), *P. multiradiatus* (Hancock, 1828) and *P. pardalis* (Castelnau, 1855) have been recorded in Mexican freshwater environments and were apparently introduced due to releases from farms or aquariums (Gozlan et al. 2010). These fishes were reported in Mexico since 1995 in Presa Adolfo Lopez Mateos, Michoacán and recently Wakida-Kusunoki et al. (2007) mentioned that they are distributed in Campeche, Chiapas and other localities of central and western Mexico. Although according to Mendoza et al. (2008) the *Pterygoplichthys* specimens found in Mexico may represent a complex of six species that have not been adequately addressed. Espinosa et al. (2011) show how to diagnose two of these species from Chiapas. From 1995 to date, this group has been fully established and expanded their distribution in Mexican rivers and reservoirs.

Ictaluridae: Five species of this family have been introduced in Mexican water systems for aquaculture. *Ictalurus furcatus* (Valenciennes, 1840) is distributed in the Atlantic coastal drainages from the Mississippi River to Guatemala, and also documented in the Pacific, in the Yaqui River and in the peninsula of Baja California, according to Contreras-B and Escalante-C (1984). *I. punctatus* (Rafinesque, 1818) is distributed in northern Mexico in the Atlantic slope, and has been introduced due to its intensive farming in many parts of the world. In Mexico it is known to occur in dams, lakes and rivers of central and northern Mexico, where it is fully established. *Ameiurus melas* (Rafinesque, 1820) and *A. natalis* (Lesueur, 1819) do not occur naturally in Mexico, but they have been introduced in many rivers for aquaculture, where they have established according to Contreras-B and Escalante-C (1984) who reported them in different localities of the Rio Pánuco, Lerma-Santiago and Balsas. *Pylodictis olivaris* (Rafinesque, 1818) is now established in the lower Rio Colorado basin, including parts of Baja California and Sonora (Miller et al. 2009). The only voucher specimen is from northwestern Mexico was captured in the junction of the Rio Colorado and Rio Hardy (Ruiz-Campos et al. 2012).

Salmonidae: There is no consensus about the number of undescribed native species of this family in Mexico (Hendrickson et al. 2002). The introduction of *Salvelinus fontinalis* (Mitchill, 1814) in the sixties in the State of Mexico was unsuccessful, and there are no recent records of its establishment. *Oncorhynchus mykiss* (Walbaum, 1792) was introduced in several parts of the country, although part of its native distribution is in the northwest of Mexico (Miller et al. 2009). This species is

fully established in many mountain areas of the country. Currently, the presence of the Brown Trout, *Salmo trutta* Linnaeus, 1758 is known only from several farms in states of Mexico and Puebla.

Atherinopsidae: Nine species of this family were translocated and introduced in different water environments in the country, mainly to serve as fodder for other introduced species such as bass, catfish and trout. Only in some cases, *Chirostoma sphyraena* Boulenger, 1900 and *C. estor* Jordan, 1880 are used as food. These introductions caused great inconvenience to taxonomists, who nowadays face several problems to determine species such as hybridizations. Other species, such as *C. aculeatum* Barbour, 1973, *C. consocium*, *C. grandocule* (Steindachner, 1894), *C. jordani* Woolman, 1894, *C. labarcae* Meek, 1902, *Membras martinica* (Valenciennes, 1835) and *Menidia beryllina* (Cope, 1867) were introduced into water bodies in northern Mexico with unknown results of such introductions (Miller et al. 2009).

Fundulidae: Two species of this family, *Fundulus zebrinus* Jordan & Gilbert, 1883 and *F. grandis* Baird & Girard, 1853 have been recorded as introduced. *Fundulus zebrinus* was reported by Contreras-B and Escalante-C (1984) in three localities in the middle Rio Grande whereas *Fundulus grandis* is distributed in Veracruz and Tamaulipas, although in Nuevo Leon and Chihuahua could be present according Contreras-Balderas (2008).

Poeciliidae: Nineteen species are considered introduced or translocated. *Gambusia affinis* (Baird & Girard, 1853) is native from Mississippi River basin from central Indiana and Illinois, south through the Golfo de México drainages and northern Veracruz (Page and Burr 1991). It was introduced in different system waters since 1931 as part of a mosquito control program. The first place where it was reported is in Arroyo San José, Baja California by Miller and Hubbs (1954), later Ruiz-Campos et al. (2012) report it again in many localities of Baja California, also it has been found mostly in some northern states of the country (Figure 1).

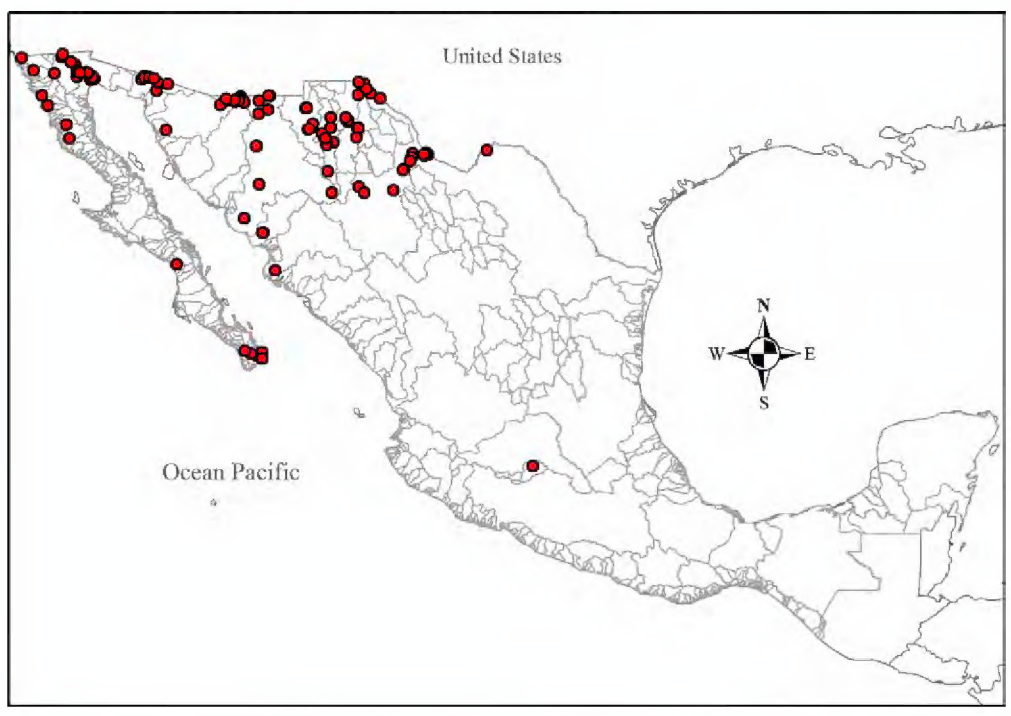

Figure 1. Traslocated distribution of Western Mosquitofish (*Gambusia affinis*) in northern country due to mosquito control programs.

There are other five species of this genus (*G. hurtadoi* Hubbs & Springer, 1957; *G. panuco* Hubbs, 1926; *G. regani* Hubbs, 1926; *G. senilis* Girard, 1859 and *G. speciosa* Girard, 1859) which have been translocated due to aquaculture or accidental release; in most cases the current status of invasion is unknown. Also it was found six species of the genus *Poecilia* (*P. butleri* Jordan, 1889; *P. latipinna* (Lesueur, 1821); *P. latipunctata* Meek, 1904; *P. mexicana* Steindachner, 1863 and *P. reticulata* Peters, 1860) five of this species are native, and have been translocated from one system to another, mainly by aquarists and by government nutrition programs. Whereas the guppy (*P. reticulata* Peters, 1859), is a native species from Guyana and Venezuela used as aquarium fish, is the most invasive exotic fish in the freshwater bodies of the central and southern Baja California Peninsula (Ruiz-Campos et al. 2012). *Heterandria bimaculata* (Heckel, 1848) is originally restricted to the Atlantic slope, but currently it can be found in several localities in the Pacific slope, mainly in the Balsas River basin the cause of its introduction is unknown although some authors mention aquaculture or accidental releases as probable causes (Contreras-Balderas 1999, Miller et al. 2009). The same was observed for *Poeciliopsis gracilis* (Heckel, 1848), but the limits of its dispersion are known, although it is thought to have hybridized with other species of the genus (Courtenay and Maffe, 1989). Seven species of the genus *Xiphophorus* (*X. couchianus* (Girard, 1859); *X. gordoni* Miller & Minckley, 1963; *X. hellerii* Heckel, 1848; *X. maculatus* (Günther, 1866); *X. meyeri* Schartl & Schröder, 1988 and *X. variatus* (Meek, 1904)) are spread in the water systems of the country due to aquarists, or have been transported with cichlids at different sites of the country, as well as with *Astyanax* and *Poecilia* species (Espinosa et al. 2011).

Cyprinodontidae: *Cyprinodon variegatus* Lacepède, 1803 was reported by Contreras-Balderas (2008) as an introduced fish. However its natural distribution is between the towns showed in Table 1. Hence, more surveys are necessary to assess this information.

Scorpaenidae: Only one species of this family, *Pterois volitans* (Linnaeus, 1758), native to the Indo-Pacific region, has been introduced into Mexican marine waters and are known to have invaded the Caribbean in Florida, where it was originally introduced. This species is a several threat to Caribbean reefs, where it has no natural competitors or predators (Betancur et al. 2011).

Moronidae: The two species of this family recorded in Mexican water bodies are *Morone chrysops* (Rafinesque, 1820) and *M. saxatilis* (Walbaum, 1792), both native to the Atlantic coast of the United States belonging to the wildlife of the template American Atlantic. *M. chrysops* is native from Mississippi River and Ohio valleys. Contreras-B and Escalante-C (1984) reported it in lower and middle Rio Grande also in Rio San Juan to Dr.

Coss, Nuevo Leon, with aquaculture purpose and sport fishing, whereas *M. saxatilis* is natural from the coastal drainages and littoral marine waters of the Atlantic, from St. Lawrence River in Canada to the south of St. Johns River in Florida (Ross 2002). Contreras-Balderas (1999) reported it in Rio Bravo and mentioned as causes of its introduction the aquaculture and sport fishing, and Mendoza et al. (2011) mentioned that this species are causing a several decrease in the native fishes of Laguna Madre because it is a voracious depredator.

Centrarchidae: Even though there are four native species in this family particularly from the Rio Grande basin (*Lepomis cyanellus* Rafinesque, 1819; *L. macrochirus* Rafinesque, 1819; *L. megalotis* Rafinesque, 1819 and *Micropterus salmoides* (Lacepède, 1802)), Sunfishes have been introduced in the north of the country for different reasons, but mainly as part of aquaculture projects. All introduced Centrarchidae species are known to be established, but the range of their distribution is unknown. This is the case of the two species of *Pomoxis (P. annularis* Rafinesque, 1818 and *P. nigromaculatus* (Lesueur, 1829), it is known that in Durango both species are completely dominant in rivers and dams causing several damages on the native fishes (Garcia de León et al. 2005).

Sparidae: In 2004, the transnational company Biotecmar S.A. received permission from the Mexican environmental authorities to establish a commercial culture of seabass in Bahía de La Paz, on the southwestern side of the Gulf of California. In September 2005, instead of introducing seabass, the company introduced at least 300,000 individuals of the gilt-head seabream *Sparus aurata* Linnaeus, 1758. On 3 October 2007 an individual of *S. aurata* was captured in the wild during experimental fishing work in the Bahía de La Paz in the Golfo de California. This fish has invaded large areas of the Mar de Cortes due to its escape (Balart et al. 2008).

Sciaenidae: *Aplodinotus grunniens* Rafinesque, 1819 was reported as introduced by Contreras-Balderas (2008).Its native distribution is along the Atlantic slope drainages in Mexico, for this reason the records in Coahuila and Nuevo Leon are considered to represent traslocation. *Sciaenops ocellatus* (Linnaeus, 1766) is a marine-estuarine species, distributed in the coastal area from Massachusetts to Veracruz, introduced in the Laguna of Términos in Campeche for fishing purposes. The establishment of the species in Laguna of Términos is unknown (Wakida-Kusunoki and Santos-Valencia 2008).

Cichlidae: Within this family there are more than 40 native species in Mexico, of which *Cichlasoma urophthalmus* (Günther, 1862), *Herichthys cyanoguttatus* Baird & Girard, 1854, *Petenia splendida* Günther, 1862, *Rocio octofasciata* (Regan, 1903), *Thorichthys ellioti* Meek, 1904 and *Theraps pearsei* (Hubbs, 1936) have been mentioned as introduced or translocated to several localities of the country. These are the cases of *Cichlasoma urophthalmus* and *Petenia splendida*, spread further their natural range of distribution in Chiapas and Oaxaca. *Herichthys cyanoguttatus* was registered as traslocated by Contreras-Balderas (2008), in different waters bodies. Some authors mentioned that this species has already hybridized with a native closely related species in Cuatro Cienegas, Coahuila, however this has not been well documented (Husley et al. 2003). *Parachromis managuensis* (Günther, 1867) and *Parachromis motaguensis* (Günther, 1867) are native species from Central America and were probably introduced to water bodies in the southeastern Mexico, and are now fully established in the Grijalva-Usumacinta basin (Miller et al. 2009). *Amatitlania nigrofasciata* (Günther, 1867) is a native species from Central America including the Pacific slope from Rio Sucio and it is considered ornamental. Figure 2 shows some records of this fish in Mexico. It is established and widely disseminated throughout the country mainly in the center and southeast of Mexico (Mendoza and Koleff 2014). *Oreochromis aureus* (Steindachner, 1864), *O. mossambicus* (Peters, 1852), *O. niloticus* (Linnaeus, 1758), *Tilapia rendalli* (Boulenger, 1897), *T. zillii* (Gervais, 1848) and *Hemichromis guttatus* Günther, 1862 are African species introduced for aquaculture in Mexico. These species have been progressively introduced in many freshwater bodies of the country, both natural and artificial for aquaculture and commercial catch. Its high capacity of competition for resources like space and food has caused the displacement of native fishes as the case of *Cyprinodon macularius* Baird & Girard, 1853, in the lower Rio Colorado basin of Baja California and Sonora (Varela-Romero et al. 2003).

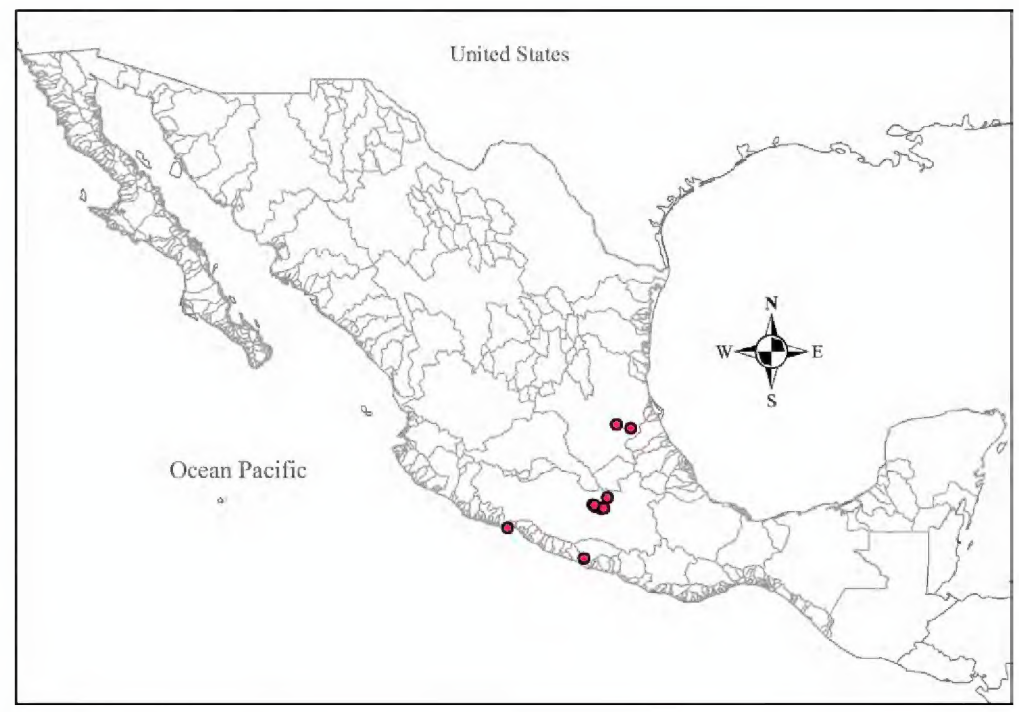

Figure 2. Map of different records of *Amatitlania nigrofasciata* observed or captured in Mexico.

DISCUSSION

In this work we reported 104 introduced fish species in Mexico, grouped into 19 families and 59 genera, representing 3.76% of the fish diversity of the country according to Espinosa-Perez (2014). Of 104 introduced

species, 62% are established with a wide distribution in the country, such as the Common Carp (*Cyprinus carpio*) and the Bream (*Oreochromis* and *Tilapia*), herein considered invasive. Forty two species are foreign, mainly natural from Asian, European and North American, and the remaining is considered translocated species. Translocation is defined here as a native species from a determined aquatic system in Mexico that has been introduced in other localities, such as some cichlids and poecilids (*Theraps pearsei, Rocio octofasciata, Amatitlania nigrofasciata*, and some species of the genera *Poecilia* and *Gambusia*).

Furthermore 20% of the species reported in this work are species of freshwater environments; this means that in the case of marine species, there is not enough information about the introduced species. Only the Lionfish (*Pterois volitans* Linnaeus, 1758) is mentioned to be widely spread in the coasts of the Golfo de Mexico and the Caribbean. There are many studies about the behavior, development, habits, genetic, effects on the environment in which it is introduced or impact on native species about this fish. Currently its eradication is considered impossible or nearly impossible due to the absence of natural depredators to control the population of this species. One alternative is the implementation in the Mexican food of this fish, some institutions like Comision Nacional de Areas Protegidas (CONANP), Secretaría del Medio Ambiente y Recursos Naturales (SEMARNAT) and the Veracruz government compiled a recipe book with the purpose of promoting the consumption of this fish in the local people and tourists.

Of the total species reported in this work, 31.4% is represented mainly by four freshwater fishes, two of them Asian natives (*Cyprinus carpio* and *Oreochromis niloticus*). The Common carp (*C. carpio*) represent 10.68%, while Largemouth Bass (*Micropterus salmoides*) 7.71%, and Nile Tilapia (*O. niloticus*) 7.61% and the Shortfin Molly (*Poecilia mexicana*) 5.4%. The first one is species used within aquaculture purpose, it was found that this is the main cause of introduction (29%), moreover there are species as the two others (*M. salmoides* and *P. mexicana*) that are used as ornamental fish or sport fishing purpose, these causes represent 15% and 12% respectively. These are not the only introduction causes, it was found that the introduction of foraging species and accidental release also represents the 12%. Only four causes represent less than 10% among them are reintroduction, it was the case of *Gila modesta* (Garman,1881); with protection purpose like the case of *G. orcuttii* (Eigenmann & Eigenmann, 1890) and *Siphateles bicolor* (Girard, 1856) while *Ctenopharyngodon idella* and *Gambusia affinis* as mentioned were introduced with bait purpose (Contreras-Balderas 1999). There is no information about the introduction of the remaining species. Therefore, they were grouped in the category "require to verify" on Table 1.

A contribution of this work is the inclusion of the Milkfish (*Chanos chanos* (Forsskål, 1775)) to the list of introduced species of Mexico. This fish is a native species from the Indo-Pacific of the family Chanidae and even though it was previously reported by Castro-Aguirre et al. (1999), it has not been considered officially as an introduced species in Mexico. According to this author, this fish was introduced to North America by the end of the last century in the San Francisco estuary for aquaculture purposes or accidental releases from the farms in the United States. The current inclusion of this species on the list is supported by specimens collected in coasts of Nayarit and deposited in the CNPE-IBUNAM (Table 1).

Another contribution is that we report the presence of the brown trout (*Salmo trutta*) in hatcheries of the state of Mexico and Puebla. This species had only been reported by Hendrickson in the early 1980s near Yaqui River in the north of Mexico, and was not mentioned in any other publication. The specimens in which we base our report were deposited in the Colección Nacional de Peces of the Instituto de Biología of UNAM with catalog number 18454 CNPE-IBUNAM.

The purpose of the electronic resources is to be able to follow up on the current situation of these species through constant update of the data. The update is possible with the help of researchers and people interested in fish introductions, and the contact with the Colección Nacional de Peces of the Instituto de Biología UNAM in Mexico through the e-mail cnpe@ib.unam.mx. Data sent in for inclusion in the database must include the locality or the place where the fish was seen or collected, the exact geographic coordinates, and a clear photograph showing the morphological characteristic of the fish. With this information we will be able to determine if it is a new record or not.

ACKNOWLEDGEMENTS

We thank C. Lambarri and Armando Martínez, who helped to improve the map and the text, and J. Jiménez and U. Melo that supported the construction of the website to the database and CONABIO that support with the general information about the list of introduced species. We also thank UNIBIO who helped the elaboration of map and the electronic database. To all collectors and friends of the Institute of Biology CNPE, that has helped to determine and collect specimens and data. To the curators of ichthyological collections that has made available their databases. The editor and two reviewers who helped with the improvement of the manuscript.

LITERATURE CITED

Balart, E.F., J.C. Pérez-Urbiola, L. Campos-Dávila, M. Monteforte and A. Ortega-Rubio. 2008. On the first record of a potentially harmful fish, *Sparus aurata* in the Gulf of California. Biological invasions 11(3): 547–550 doi.: 10.1007/s10530-008-9269-3

Betancur, R., A. Hines, A. Acero, G. Ortí, A.E. Wilbur and W. Freshwater. 2011. Reconstructing the lionfish invasion into Greater Caribbean biogeography. Journal of Biogeography 38(7): 1281–1293. doi: 10.1111/j.1365-2699.2011.02496.x

Castro-Aguirre, J.L., H. Espinosa-Pérez and J.J. Schmitter-Soto. 1999. Ictiofauna estuarina, lagunar y vicaria de México. Mexico City: Limusa. 705 pp.

CONABIO. 2008. Capital Natural de México, Vol I: Conocimiento actual de la Biodiversidad. México: CONABIO. 809 pp.

Contreras-B, S. and M.A. Escalante-C. 1984. Distribution and known impacts of exotic fishes in Mexico; pp. 102–130, in: W.R. Courtenay and J.R. Stauffer (eds.). Distribution, Biology and management of exotic fishes. Baltimore: The John Hopkins University Press.

Contreras-Balderas, S. 1999. Annotated checklist of introduced invasive fishes in México, with examples of some recent introductions; pp. 31–52; in: R. Claudi and J.H. Leach (eds.). Nonindigenous freshwater organisms: vectors, biology, and impacts. Boca Raton: Lewis Publishers.

Contreras-Balderas, S. 2008. Especies de peces introducidas en aguas continentales de México. Catálogo manuscrito Base de datos SNIB-CONABIO, Proyecto AE002, México. Accessed at http://www.conabio.gob.mx/invasoras/index.php/Especies_invasoras_-_Peces, August 2012.

Contreras-Balderas, S., G. Ruiz-Campos, J.J. Schmitter-Soto, E. Díaz-Pardo, T. Contreras-McBeath, M. Medina-Soto, L. Zambrano-González, A. Varela-Romero, R. Mendoza-Alfaro, C. Ramírez-Martínez, M.A. Leija-Tristán, P. Almada-Villela, D.A. Hendrickson and J. Lyons. 2008. Freshwater fishes and water status in México: A country-wide appraisal. Aquatic Ecosystem Health & Management 11(3): 246–256. doi: 10.1080/14634980802319986

Courtenay W.R. and G.K. Meffe. 1989. Small fishes in strange places a review of introduced Poeciliids; pp. 319-331 in G. Meffe and F. F. Snelson, Jr., (eds). Ecology and Evolution of Livebearing Fishes: Poeciliidae. New Jersey, Prentice Hall Englewood Cliffs.

Escalante, M.A. and S. Contreras. 1985. Especies exóticas. Su distribución (trasfaunadas de sus ecosistemas nativos) en la República Mexicana. Ciencias del Mar 2(7): 18-24.

Eschmeyer, W. N. and J. D. Fong. 2014. Catalog of fishes. California Academy of Sciences. Accessed at http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp, 12 December 2014.

Espinosa Pérez, H., Ma. T. Gaspar Dillanes and P. Fuentes Mata. 1993. Los Peces Dulceacuícolas Mexicanos.Listados Faunísticos de México. III. Instituto de Biología, UNAM., México City. 99 pp. http://vivanatura.org/peces%20dulceacuicolas.txt

Espinosa-Pérez H., X. Valencia-Díaz and R. Rodiles–Hernández. 2011. Peces dulceacuícolas de Chiapas; pp. 401-475 in N.F. Álvarez (ed.). Chiapas: Estudios sobre su diversidad biológica. México City: Instituto de Biología, Universidad Nacional Autónoma de México.

Espinosa-Pérez, H.S. 2014. Biodiversidad de peces en Mexico. Revista Mexicana de Biodiversidad, 84: 1–10.doi:10.7550/rmb.32264

García de León F.J., D. Gutiérrez Tirado, D. Hendrickson and H. Espinosa Pérez. 2005. Fish of the continental waters of Tamaulipas: Diversity and conservation status; pp. 138-166 in J.L. Carton, G. Ceballos and R.S. Felger (eds). Biodiversity, ecosystem and conservation in Northern Mexico. New York City: Oxford University Press.

Gozlan, R.E, J.R Britton, I Cowx and G.H Copp. 2010. Current knowledge on non-native freshwater fish introductions. Journal of Fish Biology 76 (4) 751-786. doi: 10.1111/j.1095-8649.2010.02566.x

GBIF 2012. Global Biodiversity Information Facility. Version 2013. Electronic Database accessible at http://www gbif org/. Captured on 22 June 2013.

Hendrickson D.A., W.L. Minckley, R. R. Miller, D.J. Siebert and P.H. Minckley. 1980. Fishes of the Rio Yaqui basin, Mexico and United States. Journal of the Arizona-Nevada Academy of Sciences 15(3): 65-106 (http://www.jstor.org/stable/40025038).

Hendrickson D.A., H. Espinosa-Pérez, L.T. Findley, W. Forbes, J.R. Tomelleri, R.L. Mayden J.L. Nielsen, B. Jensen, G. Ruiz-Campos, R.A. Varela, A. Heinden, F. Camarena, F. García de León. 2002. Mexican native trouts: a review of their history and current systematic and conservation status. Reviews in Fish Biology and Fisheries 12(2): 273-316 doi: 10.1023/A:1025062415188

Hulsey, C.D., García-de-León, F.J., Sánchez-Johnson, Y., Hendrickson, D.A. and T.J. Near. 2004 Temporal diversification of Mesoamerican cichlid fishes across a major biogeographic boundary. Molecular Phylogenetics and Evolution, 31(2): 754–764 doi:. 10.1016/j.ympev.2003.08.024

Ibáñez, A.L., H. Espinosa-Pérez and J.L. García-Calderón. 2011. Datos recientes de la distribución de la siembra de especies exóticas como base de la producción pesquera en aguas interiores mexicanas. Revista Mexicana de Biodiversidad 82(3): 904-914 doi: http://revistas.unam.mx/index.php/bio/article/view/27846

Lee, D.S . C.R Gilbert, C.H. Hoccut, R. E. Jenkins, D.E. McAlister, and J.R. Stauffer, Jr (eds.). 1980. Atlas of North American Freshwater Fishes. North Carolina State Museum of Natural History, Raleigh. 854 pp

Mendoza, R., S. Contreras, C. Ramírez, P. Koleff, P. Álvarez, and V. Aguilar. 2008. Los Peces Diablo. Biocenosis 23(2): 16-19

Mendoza, R., N. Arreaga, J.E. Hérnandez, V. Segovia, I. Jasso and D. Pérez. 2011. Aquatic invasive species in the Río Bravo/ Laguna Madre ecoregion. Commission for Environmental Cooperation. Montreal.Canadá.161pp

Mendoza, R. and P. Koleff. 2014. Especies acuáticas invasoras en México. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México. 560 pp

Miller, R. R., and C.L. Hubbs. 1954 An erroneous record of the California killifish, *Fundulus parvipinnis*, from Cabo San Lucas, Baja California. Copeia 1954(3): 234-235. doi:10.2307/1439216

Miller, R.R., W.L. Minckley, N.S. Mark, and M.H Gach. 2009. Peces dulceacuícolas de Mexico. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad. Mexico, D.F., 608 pp.

National Science Foundation 2012. National Science Foundation Version 2012. Electronic Database accessible at http://www.fishnet2.org. Captured on 22 June 2012.

Page, L. M. and B. M. Burr. 1991. A field guide to freshwater fishes: North America/ North of Mexico. Houghton Mifflin Co., Boston. 432 pp.

Page, L.M., H. Espinosa-Pérez, L.T. Findley, C.R. Gilbert, R.N Lea, N.E. Mandrak, R.L. Mayden and J.S. Nelson. 2013. Common and Scientific names of fishes from the United States, Canada and Mexico. Bethesda Maryland, American Fisheries Society, Special Publication 34, 383 pp.

Ruiz-Campos G, S. Contreras-Balderas, A. Andreu-Soler, A. Varela-Romero and E. Campos. 2012. Lista comentada sobre la distribución de peces dulceacuícolas exóticos de la península de Baja California, Mexico. Revista Mexicana de Biodiversidad 83(1): 216-234 http://www.scielo.org.mx/scielo.php?pid=S1870-34532012000100025&script=sci_arttext

Ross, S. T. 2002. The Inland Fishes of Mississippi. University Press of Mississippi, Jackson. 736 pp.

Salgado-Maldonado G. and R. Pineda-López. 2003. The Asian fish tapeworm *Bothriocephalus acheilognathi*: a potential threat to native freshwater fish species in Mexico. Biological Invasions 5(3): 261-268. doi: 10.1023/A:1026189331093

Varela-Romero, A., G. Ruiz-Campos, L. M. Yépiz-Velázquez and J. Alaníz-García. 2003. Distribution, habitat, and conservation status of desert pupfish (*Cyprinodon macularius*) in the Lower

Colorado River basin, Mexico. Reviews in Fish Biology and Fisheries 12:157-165. doi:10.1023/A:1025006920052

Wakida-Kusunoki, A.T., R. Ruiz-Carus and E.A. Del Ángel. 2007. Amazon sailfin catfish, *Pterygoplichthys pardalis* (Castelnau, 1855) (Loricariidae), another exotic species established in southeastern Mexico. The Southwestern Naturalist 52(1): 141-144. doi: 10.1894/0038-4909(2007)52[141:ASCPPC]2.0.CO;2

Wakida-Kusunoki A.T. and J. Santos-Valencia. 2008. Primer registro de corvineta ocelada *Sciaenops ocellatus* Linnaeus, 1766 (Perciformes: Sciaenidae) en Campeche, Mexico. Hidrobiológica 18(3):261-264. http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0188-88972008000300010&lng=es.

Wittenberg R. and M.J. Cock. 2001. Invasive alien species. A toolkit of best prevention and Manegement practices. Wellingford, Oxon, UK: CAB International. 228 pp.

Author's contribution statement: MR searched different databases, made the figures and the Table 1, made the qualitative analysis, wrote the text, and collaborated with the UNIBIO on the map and the electronic database. HE-P contributed with the text.

Received: August 2014
Accepted: March 2015
Editorial responsibility: Manoela Marinho

Table 1. List of introduced and exotic species in Mexico and their distribution. Abbreviations of the country of native distribution: Afr- Africa; AS- Southamerica; Ar- Argentina; At -Atlantic; AtW- West Atlantic; Aus- Australia; BIZ- Belice; Bra- Brazil; Can- Canada, CRC- Costa Rica; USA- United States of America; EUR- Europe; EuAs- Eurasia; ESA- El Salvador; Gua- Guatemala; GM- Golfo de México; Hon- Honduras; Mex- México; NA- Northamerica; Nic- Nicaragua; OI- Ocean Indic; Pan- Panama; Ven- Venezuela. Abbreviations of names the states in Mexico: (BC) Baja California, (BCS) Baja California Sur, (Son) Sonora, (Chih) Chiahuahua, (Sin) Sinaloa, (Dgo)Durango, (Coh) Coahuila, (NL) Nuevo León, (Zac) Zacatecas, (SLP) San Luis Potosí, (Tamp) Tamaulipas, (Nay) Nayarit, (Ags) Aguascalientes, (Jal) Jalisco, (Gto) Guanajuato, (Qro) Queretaro, (Hgo) Hidalgo, (Col) Colima, (Mich) Michoacan, (Mex) Mexico, (Mor) Morelos, (Tlaxc)Tlaxcala, (Pue) Puebla, (Ver) Veracruz, (Gro) Guerrero, (Oax) Oaxaca, (Chis) Chiapas, (Tab) Tabasco, (Camp) Campeche, (Yuc) Yucatán, (QR) Quintana Roo, (DF) Distrito Federal. Abbreviations of the introduction causes: Com- commercial, SRV- will verify, Or- ornamental, Ac- Accidental, AQ- aquaculture; Dp, sport fish; NR- no record, DSC- unknown, Re- reintroduced Abbreviations of the invasion status in the country: e- "exotic", SRV- "Requieres verification"; I-introduced Ts-traslocated, I/SRV- introduced but is necessary to verify .

Family[a]	Scientific name	Common name	Distribution native[b]	Records[c]	Cause[d]	Current status [e]	Catalog number	Resource consulted
Lepisosteidae	*Lepisosteus osseus* (Linnaeus, 1758)	Lognose Gar, catán aguja	Can, USA, Mex	Tam.	Dp	Ts		
Clupeidae*	*Dorosoma cepedianum* (Lesueur, 1818)	Gizzard Shad sardina molleja	USA and Mex	Coh., Chih., NL., Oax., Qro., Tab., Tam., Ver.	For y Ac	SRV	CNPE-IBUNAM 10612	Contreras-Balderas, (1999)
Clupeidae*	*Dorosoma petenense* (Günter, 1867)	Threadfin Shad sardina maya	NA	BC., Camp., Chis., Coh., Chih., NL., Oax., QR., SLP., Son., Tab., Tam., Ver.	For y Ac	Ts	CNPE-IBUNAM 5707	Contreras- Contreras-B and Escalante-C (1984)
Chanidae*	*Chanos chanos* (Forsskål 1775)	Milkfish sabalote	Red Sea, Indic Ocean	Son., Sin., Nay., Oax., Chis., Gro.	Com.	e	CNPE-IBUNAM 5364	Castro-Aguirre et al. *1999*
Cyprinidae*	*Abramis brama* (Linnaeus, 1758)	Freshwater bream carpa brama	EUR and As	NR	NR	Ts	Without available voucher	Monks et al. *2005*
Cyprinidae *	*Algansea lacustris* Steindachner, 1895	Pátzcuaro Chub acumara	Mex	Mich	Com	Ts	Without available voucher	Contreras- Contreras-B and Escalante-C (1984)

Continued

Table 1. *Continued.*

Family[a]	Scientific name	Common name	Distribution native[b]	Records[c]	Cause[d]	Current status [e]	Catalog number	Resource consulted
Cyprinidae *	*Campostoma anomalum* (Rafinesque, 1820)	Central Stoneroller rodapiedras del centro	Can, USA, Mex	NL., Tam, Son.	Ac	SRV	CNPE-IBUNAM 12483	Contreras-Balderas, 1999
Cyprinidae *	*Carassius auratus* (Linnaeus, 1758)	Gold Fish carpa dorada	China	Chih., Dgo., Mex., Pue., Mich., BC., Tam., Coh., SLP., Hgo., Qro., Nay., Gto., Jal., Gro., NL., Son., Oax., Mor., DF.	Com	e	CNPE-IBUNAM 2341	Contreras-Balderas, 2008
Cyprinidae *	*Ctenopharyngodon idella* (Valenciennes, 1844)	Grass Carp carpa hervibora	China	Mex, Hgo, Nay., Tab, Son, Chih., Sin., Mich., SLP., Tam., NL., Coh., Jal., Mor., Pue., Ver., Gto., Oax., Tlax.,	Com and Or	e	CNPE-IBUNAM 2048	Contreras-B and Escalante-C (1984)
Cyprinidae *	*Cyprinella lutrensis* (Baird & Girard, 1853)	Red Shiner carpita roja	USA and Mex	BC	Com	Ts	CNPE-IBUNAM 5708	Ruiz-Campos 2012
Cyprinidae *	*Cyprinus carpio* Linnaeus, 1758	Common Carp carpa común	China	Gto., Son., Chih., Pue., Mor., Jal., Tam.., Dgo., Tlax., Mich., Mex., Sin., NL., Gro., Oax., BCS., BC., Coh., Qro., Hgo., Qro., Gro., Ags., SLP., Zac., Nay.	Com and Or	e	CNPE-IBUNAM 2325	Contreras-B and Escalante-C (1984)
Cyprinidae *	*Gila bicolor* (Girard, 1856)	Tui Chub carpita colibrí	Texas	BC	NR	I	Without available voucher	Contreras-B and Escalante-C (1984)
Cyprinidae *	*Gila modesta* (Garman, 1881)	Saltillo Chub	Mex	Coh	Pr	Ts	UANL 800	Contreras-Balderas (1999)
Cyprinidae *	*Gila orcuttii* (Eigenmann & Eigenmann, 1890)	Arroyo Chub carpa arroyo	USA	BC	Pr	I/SRV	Without available voucher	Contreras-B and Escalante-C (1984)
Cyprinidae *	*Hypophthalmichthys molitrix* (Valenciennes, 1844)	Silver Carp carpa plateada	China and Rusia	Mich., Hgo., Mex., Df	Com and TR	I/e	CNPE-IBUNAM 2050	Contreras-Balderas (1999)
Cyprinidae *	*Hypophthalmichthys nobilis* (Richardson, 1845)	Bighead Carp carpa cabezona	China	Hgo	NR	e	Without available voucher	Contreras-Balderas (1999)
Cyprinidae*	*Macrhybopsis aestivalis* (Girard, 1856)	Speckled Chub carpa pecosa	Texas and Mex	Chih., Coh., NL., Tam.	NR	I/SRV	TCWC Ichtiology 6403.02	Contreras-Balderas (2008)
Cyprinidae	*Megalobrama amblycephala* Yih, 1955	Wuchang Bream carpa de Wuchang	China	Hgo	Com and TR	I/SRV	CNPE-IBUNAM 2051	INP (2012)
Cyprinidae *	*Mylopharyngodon piceus* (Richardson, 1846)	Black Carp carpa negra	China	Mex.	Com	SRV	Without available voucher	Contreras-Balderas (1999)
Cyprinidae *	*Notemigonus crysoleucas* (Mitchill, 1814)	Golden Shiner carpita dorada	Can and USA	Mex., Tam.., NL.,	Com and Ot	e	UANL 1623	Contreras-Balderas (1999)
Cyprinidae *	*Notropis amabilis* (Girard, 1856)	Texas Shiner carpita texana	Texas and Mex	Chih., Coh., NL., Sin., Tam.	NR	I	UANL 7166	Contreras-Balderas (2008)
Cyprinidae *	*Notropis chihuahua* Woolman, 1892	Chihuahua Shiner carpita chihuahuense	Texas and Mex	Dgo., Coh., Chih.	Ac	Ts	UANL 500	Contreras-Balderas (1999)
Cyprinidae *	*Pethia conchonius* (Hamilton, 1822)	Rosy Barb dardo rosado	India	NL	Com	I/SRV	UANL 1932	Contreras-B and Escalante-C (1984)
Cyprinidae *	*Pimephales promelas* Rafinesque, 1820	Fathead Minnow carpita cabezona	Can y Mex	BC., Coh., Son., Chih., Dgo., SLP., Tam.., NL., Hgo	Com and Ot	Ts	CNPE-IBUNAM 5715	Contreras-Balderas (1999)
Cyprinidae *	*Pimephales vigilax* (Baird & Girard, 1853)	Bullhead minnow carpita cabeza de toro	USA and Mex	Chih	Ot	Ts	UANL 1459	Miller et al.(*2009*)
Cyprinidae *	*Puntius titteya* Deraniyagala, 1929	Cherry Barb dardo carmesí	Sri Lanka	NL	Or	e	Without available voucher	Contreras-B and Escalante-C (1984)
Catostomidae *	*Carpiodes carpio* (Rafinesque, 1820)	River Carpsucker matalote chato	USA and Mex	Chih., NL., Qro., Son., Tam.	Com	SRV	USON 0405	Contreras-B and Escalante-C (1984)

Continued

Table 1. *Continued.*

Family[a]	Scientific name	Common name	Distribution native[b]	Records[c]	Cause[d]	Current status [e]	Catalog number	Resource consulted
Cobitidae	*Misgurnus anguillicaudatus* (Cantor, 1842)	Oriental Weather Fish Pez oriental	Siberia	Mex	Com	e	Without available voucher	Contreras-B and Escalante-C (1984)
Loricariidae *	*Pterygoplichthys disjunctivus* (Weber, 1991)	plecostoma rayado	Ven, Bra and Perú	Cam, Mich, Tab	Or and Ac	e	CPUM 3602	Sandoval-Huerta et al. (2012)
Loricariidae *	*Pterygoplichthys multiradiatus* (Hancock, 1828)	plecostoma del Orinoco	Ar Gua	Mors, Gro	Or and Ac	e	Without available voucher	Wakida-Kusunoki et al. (2007)
Loricariidae *	*Pterygoplichthys pardalis* (Castelnau, 1855)	plecostoma del Amazonas	Bra and Perú	Cam, Mich, Tab	Or and Ac	e	Without available voucher	Wakida-Kusunoki and Amador del Ángel (2008)
Ictaluridae *	*Ameiurus melas* (Rafinesque, 1820)	Black Bullhead Bagre torito negro	Can, Texas and Mex	Chih., Son., Coh., Tamp., NL.	Com	Ts	CNPE-IBUNAM 5703	Contreras-B and Escalante-C (1984)
Ictaluridae *	*Ameiurus natalis* (Lesueur, 1819)	Yellow Bullh Torito amarilloead	Can and USA	Chih., Son., Coh., BC.	Com	I/SRV	UABC 661	Ruiz-Campos et al. (2012)
Ictaluridae *	*Ictalurus furcatus* (Valenciennes, 1840)	Blue Catfish Bagre azul	USA and Mex	Chih., Tab., Oax., Tam., NL., Ver., QR., Chis., Dgo., Son., Coh., Cam.	Com	Ts	UANL 591	Ruiz-Campos et al. (2012)
Ictaluridae *	*Ictalurus punctatus* (Rafinesque, 1818)	Channel Catfish Bagre de canal	Can, USA and Mex	Chih., Son., Coh., Tamp., NL., Chis., BC.	Com	Ts	USON-0792	Ruiz-Campos et al. (2012)
Ictaluridae *	*Pylodictis olivaris* (Rafinesque, 1818)	Flathead Catfish Bagre cabeza plana	USA and Mex	Chih., NL., Tam., Son., BC., Dgo., Coh.,	Com	Ts	UABC 318	Ruiz-Campos et al. (2012)
Salmonidae *	*Oncorhynchus mykiss* (Jordan, 1892)	Rainbow Trout Trucha arcoiris	Rusia	Son, BC, Mex., Chih., Dgo., BCS., Chis., Gto., Gro., Hgo., Mich., NL., Oax., Pue.	Com	e	CNPE-IBUNAM 10633	SEPESCA (1994)
Salmonidae	*Salmo trutta* Linaeus, 1758	Brown Trout Trucha café	EUR	Mex	Dp	I	CNPE-IBUNAM 18454	Martínez-Castro pers. comm. 2013
Salmonidae *	*Salvelinus fontinalis* (Mitchill, 1914)	Brook Trout Trucha de arroyo	USA	Chis, Chih., DF., Mex., Gro., Hgo., Jal., Mich., Mor., Pue., Qro., SLP., Son., Ver.	Com	I	Without available voucher	Espinosa et al. (1993)
Atherinopsidae	*Chirostoma aculeatum* Barbour, 1973	Scowling Silverside Charal cuchillo	Mex	Chih., Gto., Jal., Mich.,	NR	Ts		
Atherinopsidae	*Chirostoma consocium* Jordan & Hubbs, 1919	Ranch Silverside Charal de rancho	Mex	Chih., Dgo., Jal., Mich.	NR	Ts	ENCB-IPN-P4663	Contreras-B and Escalante-C (1984)
Atherinopsidae	*Chirostoma estor* Jordan, 1880	Pike Silverside Pescado blanco	Mex	Chih., DF., Jal., Mich., Mor., NL., Pue., Tamp., Ver.	NR	Ts	CNPE-IBUNAM 5587	Escárcega-Rodríguez (1999)
Atherinopsidae	*Chirostoma grandocule* (Steindachner, 1894)	Bigeye Silverside Charal de lago	Mex	Chih., Coh., DF., Mex., Hgo., Mich., NL., Pue., SLP., Sin., Ver.	NR	Ts	ENCB-IPN- P580	Contreras-B and Escalante-C (1984)
Atherinopsidae	*Chirostoma jordani* Woolman, 1894	Mesa Silverside charale	Mex	Ags., Chih., Coh., Col., DF., Dgo., Mex., Gto., Gro., Hgo., Jal., Mich., Mor., Pue., Qto., QR., Sin., Tam.., Tlax.	NR	Ts	CNPE-IBUNAM 10482	Contreras-Balderas (2008)
Atherinopsidae	*Chirostoma labarcae* Meek, 1902	Sharpnose Silverside Charal de la Barca	Mex	Chih., Dgo., Gto., Jal., Mich.	NR	Ts	ENCB-IPN-P3921	Contreras-Balderas (2008)
Atherinopsidae *	*Chirostoma sphyraena* Boulenger, 1900	Bigmouth Silverside Charal barracuda	Mex	Chih., Col., Dgo., Hgo., Jal., Mich., Mor., NL	Com	Ts	CNPE-IBUNAM 2708	Contreras-Balderas (2008)
Atherinopsidae *	*Membras martinica* (Valenncienes, 1835)	Rough Silverside Pejerrey rasposo	Mex	Cam., Coh., NL., QR., Tam.., Ver., Yuc.	Ac	Ts	UANL 2106	Contreras-Balderas (1999)
Atherinopsidae	*Menidia beryllina* (Cope, 1867)	Inland Silverside Plateadito salado	USA GM	Camp., Chis., Coh., NL., Tab., Tam., Ver.,	Com	Ts	CNPE-IBUNAM 13137	Contreras-B and Escalante-C (1984)
Fundulidae	*Fundulus grandis* Baird & Girard, 1853	Gulf Killifish Sardinilla del Panuco	USA- Cuba	Chih., NL., Tam.	SRV	SRV	CNPE-IBUNAM 2390	Contreras-Balderas (2008)

Continued

Table 1. *Continued.*

Family[a]	Scientific name	Common name	Distribution native[b]	Records[c]	Cause[d]	Current status [e]	Catalog number	Resource consulted
Fundulidae	*Fundulus zebrinus* Jordan & Gilbert, 1883	Plains Killifish Sardibilla cebra	USA and Mex	Chih., NL	Com	SRV	UANL 6884	Contreras-Balderas (1999)
Poeciliidae	*Gambusia affinis* (Baird & Girard, 1853)	Western Mosquitofish Guayacón mosquito	USA and Mex	Coh	Com	Ts	CNPE IBUNAM 127	Contreras-B and Escalante-C (1984)
Poeciliidae	*Gambusia hurtadoi* Hubbs & Springer, 1957	Crescent Gambusia guayacón de Hacienda de Dolores	Mex	Chih	Ac	Ts	UANL 7192	Contreras-Balderas (1999)
Poeciliidae	*Gambusia panuco* Hubbs, 1926	Pánuco Gambusia Guayacon del panuco	Mex	Coh., Hgo., NL., Qro., SLP., Tab., Tam., Ver	NR	Ts	FISH 97527	Contreras-B and Escalante-C (1984)
Poeciliidae	*Gambusia regani* Hubbs, 1926	Forlón Gambusia Guayacón del Forlon	Mex	Chih.	Ac	Ts	UANL 6776	Contreras-Balderas (1999)
Poeciliidae	*Gambusia senilis* Girard, 1859	Blotched Gambusia Guayacón del Bravo	Texas and Mex	Chih., Dgo., Tam.	SRV	Ts	UANL 1748	Contreras-Balderas (2008)
Poeciliidae	*Gambusia speciosa* Girard, 1859	Tex-Mex Gambusia Guaycón de Nuevo León	Texas and Mex	Chih., Coh., NL., Tam.	SRV	Ts	UANL 1675	Contreras-Balderas (2008)
Poeciliidae	*Poecilia butleri* Jordan, 1889	Pacific Molly Topote del pacifico	Mex - Pan	Chis., Chih., Ch., Gro., Jal., Mich., Mor., Nay., Oax., Sin., Son	SRV	Ts	CNPE-IBUNAM 082	Ruiz-Campos et al. (2012)
Poeciliidae	*Poecilia latipinna* (Lesueur, 1821)	Sailfin Molly topote velo negro	USA and Mex	BC. Camp., Chis., NL., Oax., SLP., Son., Tab., Tam., Ver., Yuc.	Or	Ts	CNPE-IBUNAM 11772	Ruiz-Campos et al. (2012)
Poeciliidae	*Poecilia latipunctata* Meek, 1904	Tamesí Molly Topote del Tamesi	AGM	Mex, Tam., Hgo., Ver., SLP., Pue.	Or	Ts	CNPE-IBUNAM 098	Contreras-Balderas (1999)
Poeciliidae	*Poecilia mexicana* Steindachner, 1863	Shortfin Molly Topote del Atlantico	Texas, Mex, Gua, CRC	Camp., Chis., Coh., Gto., Gro., Hgo., Jal., Mich., Mor., Nay., NL., Oax., Pue., Qro., QR., SLP., Sin., Son., Tab., Tam., Tlax., Ver., Yuc.	Ac	Ts	CNPE-IBUNAM 10572	Contreras-Balderas (2008)
Poeciliidae	*Poecilia reticulata* Peters, 1859	Guppy	AS and At	Ags., BC., BCS., Coh., Mex., Gto., Gro., Hgo., Jal., Mich., Mor., Nay., NL., Oax., Pue., Qro., SLP., Ver., Yuc.	DSC	e	CNPE-IBUNAM 10547	Ruiz-Campos et al. (2012)
Poeciliidae	*Poeciliopsis gracilis* (Heckel, 1848)	Porthole Livebearer Guatapote Jaroicho	Mex - Hon	Chis., Gro., Hgo., Mex., Mor., Oax., Qro., SLP., Tab., Tam., Ver.,	Ac	Ts	Without available voucher	Miller et al.*(2009)*
Poeciliidae	*Pseudoxiphophorus bimaculatus* (Heckel, 1848)	Spottail Killifish	Mex, Biz, Hon, Gua	Ags., BC., BCS., Camp., Chis., Coh., Col., DF., Dgo., Gto., Gro., Hgo., Mex., Mich., Mor., Nay., NL., Oax., Pue., Qro., QR., SLP., Son., Tab., Tam., Ver.	DSC	I	CNPE-IBUNAM 2351	Ruiz-Campos et al. (2012)
Poeciliidae	*Xiphophorus couchianus* (Girard, 1859)	Monterrey Platyfish Espada de Monterrey	AGM	NL., Coh	Ac	Ts	UANL 7405	Contreras-Balderas (2008)
Poeciliidae	*Xiphophorus gordoni* Miller & Minckley, 1963	Cuatro Ciénegas Platyfish Espada de Cuatro Ciénegas	Mex	NL., Coh	Ac	Ts	Without available voucher	Contreras-Balderas (1999)
Poeciliidae	*Xiphophorus hellerii* Heckel, 1848	Green Swordtai Cola de espada	Mex, Biz, Hon, Gua	BC., Camp., Chis., Coh., DF., Dgo., Gto., Gro., Hgo., Jal., Mich., Mor., NL., Oax., QR., SLP., Tab., Ver.	Or	Ts	CNPE-IBUNAM 1248	Ruiz-Campos et al. (2012)
Poeciliidae	*Xiphophorus meyeri* Schartl & Schröder, 1988	Marbled Swordtail espada de Muzquiz	Mex	Coh	SRV	Ts	Without available voucher	Contreras-Balderas (2008)
Poeciliidae	*Xiphophorus maculatus* (Günther, 1866)	Southern Platyfish Espada del sureste	Biz, Gua	BCS., Camp., Coh., Chis., Jal., Mich., Mor., Nay., NL., Oax., QR:, Tabs., Tam., Ver.,	Or	Ts	CNPE-IBUNAM 077	Ruiz-Campos et al. (2012)

Continued

Table 1. *Continued.*

Family[a]	Scientific name	Common name	Distribution native[b]	Records[c]	Cause[d]	Current status [e]	Catalog number	Resource consulted
Poeciliidae	*Xiphophorus variatus* (Meek, 1904)	Variable Platyfish Espada de Valles	Mex	DF., Gto., Jal., Mor., NL., Pue., SLP., Son., Tam., Ver.	Or	Ts	CNPE-IBUNAM 7572	Contreras-Balderas (1999)
Cyprinodontidae	*Cyprinodon variegatus* Lacepède, 1803	Sheepshead Minnow Bolin petota	USA y Mex	Coh., NL., Tam.	SRV	SRV	CNPE-IBUNAM 4597	Contreras-Balderas (2008)
Scorpaenidae *	*Pterois volitans* (Linnaeus, 1758)	Red Lion Fish Pez león	OI and Aus	Yuc	Com	e	CIR-UADY 1466	Aguilar et al. *(2010)*
Moronidae *	*Morone chrysops* (Rafinesque, 1820)	White Bass Lobina blanca	Can, USA	Chis., Coh., NL., Tam.,	Ac	I	UANL 6016	Contreras-Balderas (1999)
Moronidae *	*Morone saxatilis* (Walbaum, 1792)	Striped Bass Lobina estriada	NA	Chih., Coh., BC.	Dp and Ac	SRV	UANL 5610	Contreras-Balderas (1999)
Centrarchidae	*Ambloplites rupestris* (Rafinesque, 1817)	Rock Bass Lobina de roca	Can and USA	Chih	Dp and For	SRV	FISH 208261	Contreras-B and Escalante-C (1984)
Centrarchidae	*Lepomis auritus* (Linnaeus, 1758)	Redbreast Sunfish Mojarra pecho rojo	Can and USA	Mor., Tam., Coh.	For	I/SRV	Without available voucher	Contreras-B and Escalante-C (1984)
Centrarchidae	*Lepomis cyanellus* Rafinesque, 1819	Green Sunfish Pez sol	Can, USA, and Mex	BC., Coh., Chih., Dgo., Gto., Mex., Mor., NL., SLP., Son., Tam., Zac.	For	SRV	CNPE-IBUNAM 12596	Ruiz-Campos et al. (2012)
Centrarchidae	*Lepomis gulosus* (Cuvier, 1829)	Warmouth Mojarra golosa	USA	Ags., BC., Coh., NL., Tam., Zac	For	e	UABC 1051	Ruiz-Campos et al. (2012)
Centrarchidae *	*Lepomis macrochirus* Rafinesque, 1819	Bluegill Mojarra oreja azule	Can-Mex	Ags., BC., Chih., Coh., DF., Dgo., Gto., Gro., Hgo, Jal., Mex., Mor., Nay., NL., Pue., Qro., SLP., Son., Tam., Ver., Zac.	Com/ For	Ts	CNPE-IBUNAM 7032	Ruiz-Campos et al. (2012)
Centrarchidae	*Lepomis marginatus* (Holbrook, 1855)	Dollar Sunfish Pez dólar sol	USA	Chih	For	I/SRV	UANL 6823	Contreras-Balderas (2008)
Centrarchidae	*Lepomis megalotis* (Rafinesque, 1820)	Longear Sunfish Mojarra orejona	USA and Mex	Chih., Coh., Dgo., NL., Son	For	I	KUI 2989	Contreras-Balderas (2008)
Centrarchidae	*Lepomis microlophus* (Günther, 1859)	Redear Sunfish Mojarra oreja roja	USA	BC., Son., Tam.	For	Ts	UANL 6103	Contreras-Balderas (2008)
Centrarchidae	*Lepomis punctatus* (Valenciennes, 1831)	Spotted Sunfish Pez sol manchado	USA	NR	For	I	Without available voucher	Contreras-Balderas (2008)
Centrarchidae	*Micropterus dolomieu* Lacepède, 1802	Smallmouth Bass lobina	Can and USA	Coh., NL	Dp	I	Without available voucher	Contreras-B and Escalante-C (1984)
Centrarchidae *	*Micropterus salmoides* (Lacepède, 1802)	Largemouth Bass Lobina negra	USA	Ags., Bc., Chis., Chih., Coh., Dgo., Gto., Gro., Hgo., Jal., Mex., Mich., Mor., Nay., NL., Pue., Qro., SLP., Sin., Son., Tam., Ver., Zac.	Dp	I	CNPE-IBUNAM 15775	Contreras-B and Escalante-C (1984)
Centrarchidae *	*Pomoxis annularis* Rafinesque, 1818	White Crappie Carpita blanca	Can and USA	BC, Dgo., NL., Son., Tam.	Dp	Ts	CNPE-IBUNAM 15561	Ruiz-Campos et al. (2012)
Centrarchidae	*Pomoxis nigromaculatus* (Lesueur, 1829)	Black Crappie mojarra negra	USA	BC., Son., Dgo., Tam.	Dp	I	CNPE-IBUAM 067	Ruiz-Campos et al. (2012)
Sparidae *	*Sparus aurata* Linnaeus, 1758	Gilthead seabream dorada	EUR	GC	Com	e	CIBN 4336	Balart et al. (2008)
Sciaenidae	*Aplodinotus grunniens,* Rafinesque, 1819	Freshwater Drum Roncador de agua dulce	Can - Gua	Coh., NL.,	SRV	SRV	Without available voucher	Contreras-Balderas (2008)
Sciaenidae *	*Sciaenops ocellatus* Linnaeus, 1766	Red Drum Corvineta ocelada	USA and Mex	Camp	Ac	Ts	ECOSC 5595	Wakida-Kusunoki and Santos-Valencia (2008)

Continued

Table 1. *Continued.*

Family[a]	Scientific name	Common name	Distribution native[b]	Records[c]	Cause[d]	Current status [e]	Catalog number	Resource consulted
Cichlidae	*Amatitlania nigrofasciata* (Günther, 1867)	Convict cichlid Mojarra convicto	CRC, ESA, Gua, Hon, Nic, Pan	Mich., Mor., Hgo	Or	I	CNPE-IBUNAM 105	Contreras-Balderas (1999)
Cichlidae	*Cichlasoma urophthalmus* (Günther, 1862)	Mexican Mojarra Mojarra mexicana	Biz Gua, Hon, Mex and Nic	Camp., Chis., Mich., Oax., QR., Tab., Ver., Yuc.	Com	I	CNPE-IBUNAM 10582	Contreras-B and Escalante-C (1984)
Cichlidae *	*Hemichromis guttatus* Günther 1862	Spotted Jewelfish Pez joya	Afr	Coh.,	Com	e	UANL 15389	Contreras-Balderas and Ludow (2003)
Cichlidae *	*Herichthys cyanoguttatus* Baird & Girard, 1854	Rio Grande Cichlid Mojarra del norte	USA y Mex	BCS., Chis., Chih., Coh., Gro., Hgo., Mor., NL., Pue., Qrto., SLP., Tab., Tam., Ver.	Or	I	CNPE-IBUNAM 102	Contreras-Balderas (1999)
Cichlidae *	*Oreochromis aureus* (Steindachner, 1864)	Blue Tilapia Tilapia azul	EuAs and Afr	Ags., BC., BCS., Chis., Chih., Coh., Col., DF., Dgo., Gto., Gro. Hgo., Jal., Mich., Mex., Mor., NL., Oax., Qro., SLP., Sin., Tab., Tam., Ver.	Com	e	CNPE-IBUNAM 11832	Contreras-B and Escalante-C (1984)
Cichlidae *	*Oreochromis mossambicus* (Peters, 1852)	Mozambique Tilapia Tilapia de Mozambique	Afr	BC., Chis., Coh., Chih., Col., Dgo., Gto., Gro., Hgo., Jal., Mich., Mex., Mor., Nay., Oax., Pue., Qrto., SLP., Sin., Son., Tab., Tam., Ver.	Com	e	CNPE-IBUNAM 10287	Espinosa et al. (1993)
Cichlidae *	*Oreochromis niloticus* (Linnaeus, 1758)	Nile Tilapia tilapia del Nilo	Afr	BCS., Camp., Chis., Gro., Hgo., Jal., Mich., Mex., Mor., Nay., Oax., SLP., Ver.	Com	e	CNPE-IBUNAM 094	Espinosa et al. (1993)
Cichlidae	*Parachromis managuensis* (Günther, 1867)	Jaguar Guapote Mojarra de Managua	CRC	Camp., Chis., Jal., Tab.,	Ac/AQ	SRV	UMMZ 223246	Contreras-Balderas (1999)
Cichlidae	*Parachromis motaguensis* (Günther, 1867)	Motagua Cichlid Mojarra de Motagua	ESA, Gua, Hon	Tab., Camp	Ac/AQ	SRV	CNPE-IBUNAM 8886	Contreras-Balderas (1999)
Cichlidae	*Petenia splendida* Günther, 1862.	Giant Cichlid tenguayaca	Mex, Gua, Biz	Camp., Chis., Oax., QR., Tab., Ver.	Com	SRV	CNPE-IBUNAM 8949	Contreras-B and Escalante-C (1984)
Cichlidae	*Rocio octofasciata* (Regan, 1903)	Jack Dempsey Mojarra castarrica	Mex-Hon	Camp., Chis., Mor., Oax., QR., Tab., Ver., Yuc	Com	Ts	CNPE-IBUNAM 10202	Contreras-B and Escalante-C (1984)
Cichlidae	*Theraps pearsei* (Hubbs, 1936)	Pantano Cichlid Mojarra zacateca	Mex and Gua	Camp., Chis., Oax., Tab.	Com	SRV	CNPE-IBUNAM 8961	Contreras-Balderas (1999)
Cichlidae *	*Thorichthys ellioti* (Meek, 1904)	Spotcheek Cichlid chescla	Mex	Camp., Chis., Oax., QR., Tab., Ver.	Com	Ts	FISH 29019	Contreras-Balderas (2008)
Cichlidae *	*Tilapia rendalli* (Boulenger, 1897)	Redbreast tilapia Tilapia pecho rojo	Afr	Chis., Hgo., Mich., Oax., Sin., Tab., Ver.	Com	E	CNPE-IBUNAM 9082	Contreras-Balderas, (1999)
Cichlidae *	*Tilapia zillii* (Gervais, 1848)	Redbelly Tilapia Tilapia panza roja	Afr and EuAs	BC., BCS., Sin., Son.,	Com	E	UABC 1299	Ruiz-Campos et al. (2012)

* suggest exotic species from other countries.